Kernel Debug for Microsoft® Windows® Server 2003 on HP Integrity Servers

May 2004 (First Edition)
Part Number 368341-001

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Contents

Introduction

HP Integrity servers running Microsoft Windows Server 2003 can be configured to support Windows OS kernel debugging. This document provides the software and hardware requirements, instructions on how to set up and run the debugging environment, and troubleshooting tips and tricks.

Supported Servers

- HP zx1 chipset: rx2600, rx4640, rx5670
- HP sx1000 chipset: rx7620, rx8620, Superdome

Who Should Use the Microsoft Windows OS Kernel Debugger

The Windows OS Kernel Debugger is a sophisticated debugging and troubleshooting tool intended for use by software and hardware developers and advanced IT support personnel, who already understand the inner workings of the Windows OS Kernel. Knowledge of operating system and kernel design is a pre-requisite for using the Windows OS Kernel Debugger, as it is a detailed, low-level, engineering tool.

Setting up the Windows OS Kernel Debug Environment

This section will describe the software, hardware, and set up that is necessary to get the Windows OS Kernel Debug Environment operational.

Hardware Requirements

1. HP Integrity server (with one or more cell boards installed if sx1000-based).
2. Laptop or workstation with a serial port.
3. RJ45 to DB9F converter for rx5670, rx7620, rx8620, and Superdome (please see Appendices A and B for additional information).
4. DB9 Female-terminated RS-232 Null Modem Cable for rx2600 and rx4640 (see Appendix A for port locations).
5. A standard 4-pair CAT-5 cable with RJ45 Connectors if using the RJ45 to DB9F converter.

Software Requirements

1. Microsoft Debugging Tools for Windows package:

   Microsoft Kernel Debugger is downloadable from:

   http://www.microsoft.com/whdc/ddk/debugging/default.mspx

Please note Microsoft ships a 32-bit debugger client capable of debugging 64-bit OS installations, as well as a 64-bit debugger client. The typical configuration is to connect a 32-bit laptop or workstation as the debugger client to a 64-bit target system.

2. KD.EFI utility:

   KD.EFI is an HP utility that is downloadable from the www.hp.com website. It can also be found on Smart Setup 3.10 or greater.

Required Steps for Enabling OS Debugging

Step	HP Integrity Servers					Description of Procedure	Operating System Run State
	rx2600	rx4640	rx5670	rx7620 rx8620	Super Dome		
1	X	X	X	X	X	Setting up the Hardware	The OS can be up or down.
2				X		Add KD utility to the EFI Partition.	The OS must be up.
3	X	X	X	X	X	Enabling Live Debug in the OS	The OS can be up or down. Procedure is simpler while the is running.
4				X	X	Determining the Cell to attach the debugger to	The OS can be up or down. Procedure is simpler with OS down.
5		X		X		Enabling the Kernel Debugger Port	The OS must be down for rx7620/rx8620. Power must be off for rx4640.
6			X	X	X	Construct the RJ45 to DB9F adapter.	N/A
7	X	X	X	X	X	Attach the Debugger to the System	The OS can be up or down. Kernel Debugger should be attached prior to booting the OS to see messages.

The above table shows the optimum path to configure the server for Live Kernel debugging.

HP recommends performing steps 4 and 5 with the system down. Since step 3 requires the OS to be rebooted for the change to take effect (that is Live Debugging to be enabled) steps 4 and 5 can be performed during the reboot cycle.

Setting up the Hardware on rx5670, rx7620, rx8620 and Superdome Servers

Connect the hardware as shown in the diagram below (Fig. 1). The serial port on the Laptop or Workstation should connect to the RJ45 to DB9 Converter (see Appendix B for pin-out instructions on building a converter). One end of the 4-pair CAT-5 cable should connect to the RJ45 to DB9 Connector. The other end of the 4-pair CAT-5 cable should connect to the Debug Port as follows:

- to the rx5670 main board (see Appendix A, Fig. 6 for location)
- to the Core Cell of a partition in the HP Integrity rx7620 or rx8620 or Superdome server (see next sections or Appendix D to find out which Cell is the “Core” Cell, as well as a diagram of where the RJ45 connector is located on the Cell board).

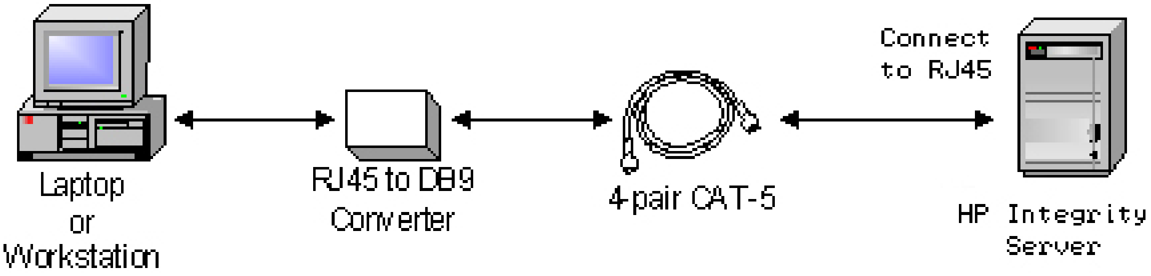


Figure 1: Setting up the Hardware with an RJ45 adapter.

Add KD Utility to the EFI Partition (rx7620 and rx8620 only)

The HP Integrity rx8620 and rx7620 have a Kernel Debugger Port that is shared with a Support Debug Port (used by HP field personnel).

The default state for this shared port is to function as a Support Debug Port, and so it normally is not enabled for use as a Windows Kernel Debugger. To enable the port for Windows Kernel Debugging, you must use the EFI-based application called KD.EFI.

KD.EFI must be executed at the EFI shell, and the Operating System must be shut down in order to access the EFI shell. However, before that occurs, the utility must be copied to the EFI System Partition, which is most easily done in the Windows operating system using the command MOUNTVOL.EXE. Administrative privileges are required to use this command.

For the EFI System Partition to be addressable from the Windows Operating System, a drive letter must be identified to use with the EFI System Partition. In the following example command, the E drive is used:

```
mountvol e: /s
```

The /s option mounts the EFI System Partition so the Operating System recognizes it as a normal drive. Copy or Drag and Drop operations can be used to copy files. Please note that this operation does not mount the EFI System Partition persistently across reboots.

Setting Up the Hardware on rx2600 and rx4640 Servers

Connect the hardware as shown in the diagram below (Fig 2.). The serial port on the Laptop or Workstation should connect directly to the DB9 port in the back of the server. (See Appendix A, Figures 4 and 5 for connector locations.) The required cable is a standard DB9 Female-terminated RS-232 Null Modem Cable.

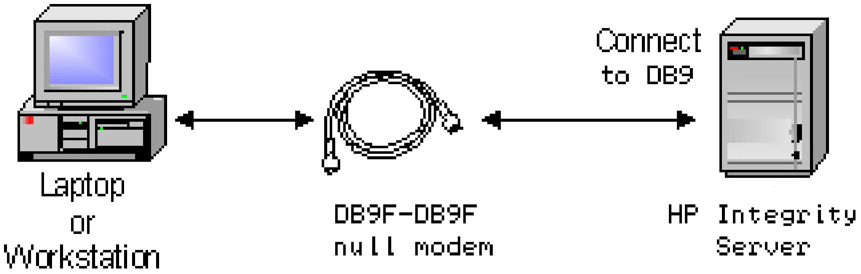


Figure 2: Setting up the hardware with a DB9 null modem cable.

Enabling the OS for Live Debugging

Enabling Debug is done by using the BOOTCFG.EXE utility that is part of the Windows 2003 Operating System and is very similar to configuring the option in 32-bit Windows. To execute BOOTCFG.EXE you must have administrative privileges.

The only real difference with the HP Integrity server is that there is no COM port specified, since the Operating System is already presented with the Cell board’s serial connector as a debugging port only. This means that the options that must be specified are the DEBUG and BAUD option only. The following example shows how to reconfigure these options on the server with the operating system running. An alternative option is to configure Live Debugging with the operating system down at the EFI shell. This is discussed in Appendix C.

The current boot configuration can be listed by typing the following at a command line with the Operating System up:

```
C:\>bootcfg


Boot Options
------------
Timeout:              20
Default:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS
CurrentBootEntryID:   1
```

```
Boot Entries
------------

Boot entry ID:    1
OS Friendly Name: Windows Server 2003, Enterprise
OsLoadOptions:    /redirect
BootFilePath:
\Device\HarddiskVolume1\EFI\Microsoft\WINNT50\ia64ldr.efi
OsFilePath:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS

Boot entry ID:    2
OS Friendly Name: Internal Bootable DVD

Boot entry ID:    3
OS Friendly Name: EFI Shell [Built-in]
```

It can be seen from the example above that Boot Option 1 is the default Windows boot option, and it only has the Out Of Band management (EMS or SAC prompt) configured as an option (the “redirect” option). On some systems the “novesa” option could be listed here too. An option must be added to facilitate Live Debugging.

To enable Live Debugging for the server the preferred method is to make a copy of the boot entry, and add the options needed afterwards. Please note, optionally it is possible to then move the new debug enabled line to be the default boot option. If the debug entry is made to be default, after successful debugging the original boot entry must be moved back to default. It is recommended to run debug mode while debugging, and not all the time.

The next step is to make a copy of the default boot entry by issuing the following command

```
   C:\>bootcfg /copy /d "Windows Server 2003, Enterprise with
   Debugging Enabled" /id 1

SUCCESS: Made a copy of the boot entry "1".
```

This has copied Boot Entry ID 1 and made it the last entry in the list. In this case, since we only have 3 boot entries, the copied Boot Entry will be ID 4, but on other systems with more options this would be a different number. The bootcfg command is issued again to show the newly added Boot Entry ID 4.

```
C:\>bootcfg

Boot Options
------------
Timeout:            20
```

```
Default:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS
CurrentBootEntryID:  1


Boot Entries
------------


Boot entry ID:    1
OS Friendly Name: Windows Server 2003, Enterprise
OsLoadOptions:    /redirect
BootFilePath:
\Device\HarddiskVolume1\EFI\Microsoft\WINNT50\ia64ldr.efi
OsFilePath:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS


Boot entry ID:    2
OS Friendly Name: Internal Bootable DVD


Boot entry ID:    3
OS Friendly Name: EFI Shell [Built-in]


Boot entry ID:    4
OS Friendly Name: Windows Server 2003, Enterprise with Debugging
Enabled
OsLoadOptions:    /redirect
BootFilePath:
\Device\HarddiskVolume1\EFI\Microsoft\WINNT50\ia64ldr.efi
OsFilePath:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS
```

Note Boot Entry 4 is the same as Boot Entry 1 with the exception of the description (OS Friendly Name) that is different.

The Debug and Baud options can now be added to Boot Entry 4 by using the following command

```
C:\>bootcfg /debug on /baud 115200 /id 4
SUCCESS: The OS load options have been changed for the BootID: 4.
```

Note that the boot entry has been configured for a baud rate of 115200. Some laptops may not support this speed, in which case a different value such as 38400 can be used. Remember to use the same value in the kernel debug application where appropriate.

To confirm that the entries were added correctly simply use the bootcfg command again, which will show an output similar to the example below.

```
C:\>bootcfg


Boot Options
------------
Timeout:             20
Default:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WI
NDOWS
CurrentBootEntryID:  1


Boot Entries
------------


Boot entry ID:    1
OS Friendly Name: Windows Server 2003, Enterprise
OsLoadOptions:    /redirect
BootFilePath:
\Device\HarddiskVolume1\EFI\Microsoft\WINNT50\ia64ldr.efi
OsFilePath:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDO
WS


Boot entry ID:    2
OS Friendly Name: Internal Bootable DVD


Boot entry ID:    3
OS Friendly Name: EFI Shell [Built-in]


Boot entry ID:    4
OS Friendly Name: Windows Server 2003, Enterprise with Debugging
Enabled
OsLoadOptions:    /redirect /debug /baudrate=115200
BootFilePath:
\Device\HarddiskVolume1\EFI\Microsoft\WINNT50\ia64ldr.efi
OsFilePath:
\Device\HarddiskDmVolumes\PhysicalDmVolumes\BlockVolume1\WINDOWS
```

Boot Entry ID 4 now shows the debug and baud rate switch. As discussed earlier, a COM port entry is not required for HP Integrity servers.

Optional Step

Optionally, the debug boot entry can be configured to be the default boot entry, although before implementation this option should be considered very carefully. Every time the system is rebooted the debug option is enabled, and this is not desirable for a production system since performance will be slightly impaired. Please note HP recommends that the debug option is only used for debugging and not installed by default. It can be installed as default temporarily, until debugging is completed, but then the original Boot Entry should be changed back to default.

To enable the debug Boot Entry as the default, the following command should be used (again the boot entry for the created debug option on the system may be a different ID to the example shown below. The example shows the Boot Entry ID as 4)

```
C:\>bootcfg /default /id 4

SUCCESS: The boot entry line "4" has been made as the default boot
entry.
```

The Debug Boot Entry will now be the default.

Restoring the Original Boot Entry after Optional Step

The original boot entry will be shifted down to ID 2. To restore Boot Entry ID 2 as the default, simply re-issue the above command with an ID of 2, as in this example:

```
C:\>bootcfg /default /id 2
```

Determining the Core/Root Cell on the HP Integrity sx1000 Servers

The terms “Core Cell” and “Root Cell” are synonymous with each other. The Partitioning Commands that are part of the ParCli product use the term “Core” whilst the EFI commands generally use the term “Root Cell”.

Each Cell board has an RJ45 connector situated in the middle of the Cell that can have a debugger attached to it. However, for partitions that have more than one Cell configured, the debugger cable must be attached to the RJ45 connector located on the Core/Root cell, and as such the hardware location of that Cell must be determined.

The following procedure explains how to determine the Root/Core Cell to attach the debugger at the EFI Shell. Unfortunately, this means the Operating System must be down. An alternative to the procedure is listed in Appendix D, which allows the Operating System to remain up, but is much more complex. Due to the very small time window needed to execute this step at EFI, HP recommends completing this procedure at EFI since the Operating System must come down for the step afterwards.

To identify the Core/Root cell, you must use the EFI command “rootcell”. This command can be executed once the option “EFI Shell” is selected at the Boot Control Manager.

Below is an example of the output:

```
fs1:\> rootcell
```

```
Preferred  Cab/
Root Cell  Slot   Warnings
---------  -----  --------
        0  0/0

The current root cell is 0.
```

From the above example we know that Core/Root cell is Cell 0, or physically the top-most Cell.

Enabling the Kernel Debugger Port for rx7620 and rx8620

The utility KD.EFI is needed in addition to the standard operating system enabling of the port (with the use of BOOTCFG). The "kd" utility has two options: "-on" and "-off". To enable the port for Windows debugging, the option “-on” must be executed at the EFI shell. Example output is shown below.

```
Shell> kd -on
============================
KD Kernel Debug Port Enabler
============================
The KD port has been turned ON
Any changes to the KD port will remain persistent across reboots
and power down, as long as power is supplied to the server.
Shell>
```

Now, the shared port on the Root/Core Cell will be enabled for Windows Kernel Debugging.

The state of the port is persistent across reboots. Use of "kd -off" from the EFI shell to manually disable the debug port and return the system to its default state.

Removing power to the system reverts the debug port to its default state. This step has to be repeated any time the server’s power is removed or lost.

To find out if Windows Debugging is enabled on the Root/Core Cell, simply type “kd” without any options and the current configuration of the Debug port is displayed.

Enabling the Kernel Debugger Port for rx4640

The HP Integrity rx4640 server has 3 DB9 connectors on the rear I/O panel. The connector labeled “remote” (the one closest to the VGA connector) is used as the Windows kernel debug port, but it is not enabled by default.

To enable the debug port you will have to physically open the server’s I/O bay and short a jumper header (jumper not provided).

1. Ensure that the system is powered off and disconnected from the AC mains.
2. Locate a set of 3 jumpers directly above the brown edge connector socket (resembles an AGP slot) on the motherboard (Fig. 3).
3. Short the middle jumper header labeled “console mux”.
4. Power on the server. The “remote” DB9 port can now be used as a debug port with a DB9 Female-terminated RS-232 Null Modem Cable.

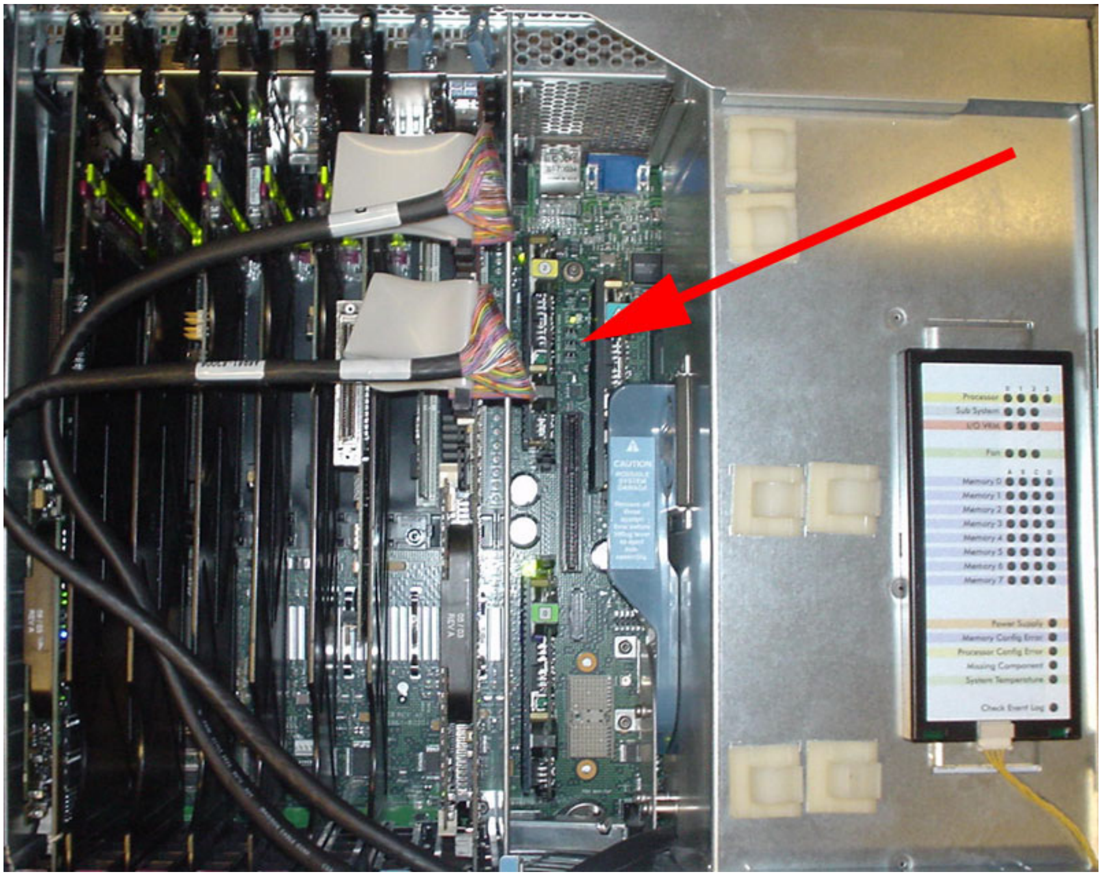


Figure 3. Location of a group of 3 jumpers on the rx4640 main board.

How to Install and Run the Microsoft Debugger

For additional information go to the Microsoft website at:
http://www.microsoft.com/whdc/ddk/debugging/default.mspx

Refer to the debugger documentation for setting up a kernel debug client. Ensure that the debugger’s baud rate matches the one specified in the boot loader options.

Appendix A: Debug Port Locations

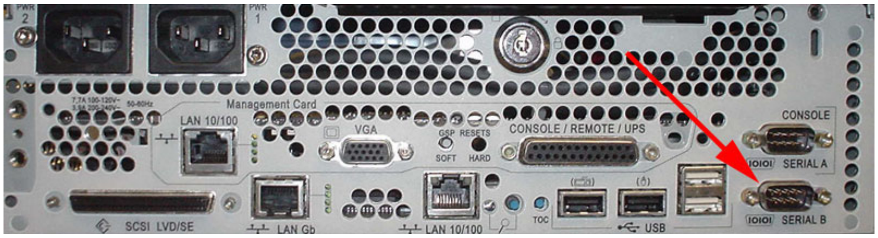


Figure 4. Location of debug port on rx2600 server.

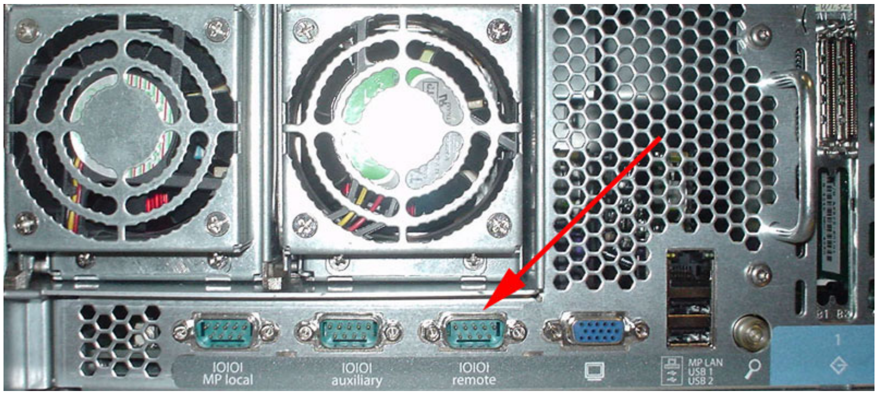


Figure 5. Location of debug port on rx4640 server.

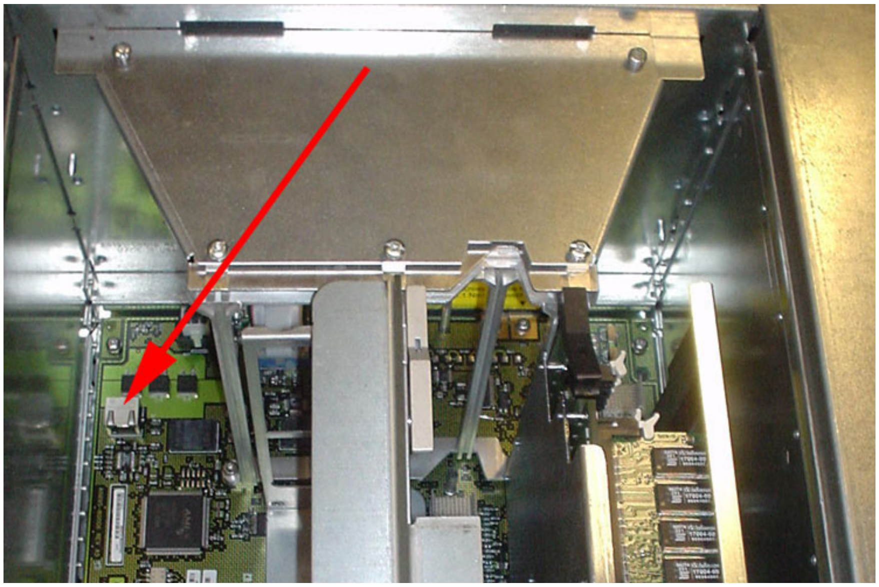


Figure 6. Location of RJ45 debug port on the rx5670 server.

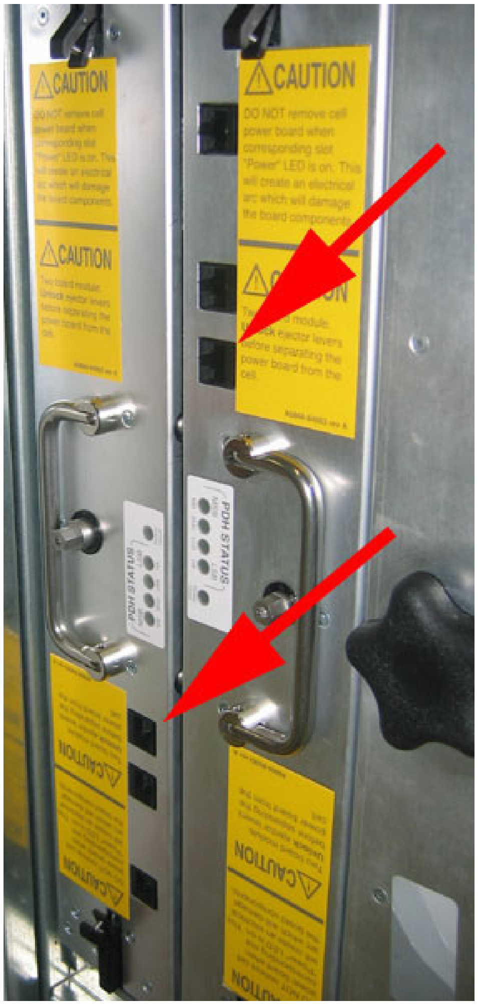

CAUTION
DO NOT remove cell power board when corresponding slot "Power" LED is on. This will create an electrical arc which will damage the board components.
CAUTION
Two board module: Unlock ejector levers before separating the power board from the cell.
PDH STATUS

Figure 7. Location of RJ45 debug port on a Superdome server Cell(s).

Note: There are 2 orientations in which the HP Integrity Superdome cells may be installed. Figure 7 shows 2 adjacent cells and the kernel debug ports on each. Always make sure to use the RJ-45 connector closest to the handle. Of course, there will be only one active debug port for a given partition that may span 1 or more non-consecutive cells. The cell containing the debug port will be the root/core cell. For discussion on root cells please refer to previous sections or Appendix D.

For HP Integrity rx7620 and rx8620 server debug ports, please see Appendix D, Fig. 8. There will be only one RJ45 connector to chose from. Other rules conform to those of the Superdome.

Appendix B: Debug Port Adapter Pin Out

HP Integrity servers rx2600 and rx4640 only require a DB9 Female-terminated RS-232 Null Modem Cable.. Refer to the next section for adapter configuration for the other integrity servers.

The kernel debug ports of the HP Integrity rx5670, rx7620/rx8620 and Superdome servers require an RJ45-terminated CAT-5 cable connected to the root cell of the partition under debug and a DB9 to RJ45 adapter.

The Pin Out for the HP Integrity rx5670, rx7620/rx8620 and Superdome kernel debug port adapters are shown in the tables below.

HP Integrity Superdome Kernel Debug Port Adapter Pin Out		
RJ45 Receptacle Pin	**Wire Color**	**DB9 Female Pin**
1	Blue	7
2	Orange	5
3	Black	NC
4	Red	8
5	Green	3
6	Yellow	NC
7	Brown	2
8	Gray (White)	NC

HP Integrity server rx8620/rx7620 Kernel Debug Port Adapter Pin Out		
RJ45 Receptacle Pin	**Wire Color**	**DB9 Female Pin**
1	Blue	4
2	Orange	8
3	Black	5
4	Red	3
5	Green	2
6	Yellow	NC
7	Brown	7
8	Gray (White)	6

HP Integrity server rx5670 Kernel Debug Port Adapter Pin Out		
RJ45 Receptacle Pin	**Wire Color**	**DB9 Female Pin**
1	Blue	1
2	Orange	3
3	Black	2
4	Red	4
5	Green	5
6	Yellow	6
7	Brown	7
8	Gray (White)	8

Appendix C

Enabling Live Debug with the Operating System Down (optional procedure to Enabling Live Debug in the OS)

1. From the EFI Shell, go to the MSUTIL directory and execute the NVRBOOT.EFI command.

   ```
   fs1:\> dir
   Directory of: fs1:\

     03/25/03  05:00a              841,216  SETUPLDR.EFI
     06/25/03  11:14a <DIR>          1,024  EFI
     06/25/03  11:14a <DIR>          1,024  MSUtil
             2 File(s)     841,343 bytes
             2 Dir(s)

   fs1:\> cd msutil
   fs1:\MSUtil> nvrboot
   ```

2. Select **M(Modify)** to modify the OS boot loader.

   ```
   Select> m
   ```

3. Enter OS boot option to modify.

   Enter OS boot option to modify: 1

4. Enter VAR to modify: 2

   1 LoadIdentifier = Windows Server 2003, Datacenter

   2 OsLoadOptions = /REDIRECT /NOVESA

   3 EfiOsLoaderFilePath = cf5f2ddc-b885-11d7-b831-000000000000 :: \efi\microsoft\winnt50\ia64ldr.efi

   4 OsLoaderFilePath = e605a034-b885-11d7-b831-000000000000 :: \windows

   Enter var to modify: 2

5. Retype OsLoadOptions with the /DEBUG /BAUDRATE=115200 option.

   Enter var to modify: 2

   OsLoadOptions = /REDIRECT /NOVESA /DEBUG /BAUDRATE=115200

NOTE: The /NOVESA switch is only needed for systems that have a VGA card installed in the partition, otherwise this option may not be present.

6. The /DEBUG /BAUDRATE=115200 is now in the OsLoadOptions.

   1 LoadIdentifier = Windows Server 2003, Datacenter

   2 OsLoadOptions = /REDIRECT /NOVESA /DEBUG /BAUDRATE=115200

   3 EfiOsLoaderFilePath = cf5f2ddc-b885-11d7-b831-000000000000 :: \efi\microsoft\winnt50\ia64ldr.efi

   4 OsLoaderFilePath = e605a034-b885-11d7-b831-000000000000 :: \windows

7. Exit and boot the OS.

Please note after completing live debugging, “/DEBUG” and “/BAUDRATE=115200” should be removed from the OsLoadOptions path, and the system rebooted in order for Windows 2003 to initialize without extra debugging options. It is standard practice to remove debug options from the boot configuration once debugging is finished.

Appendix D

Determining the Root/Core Cell on the HP Integrity rx7620, rx8620, and Superdome Servers

The terms “Core Cell” and “Root Cell” are synonymous with each other. The Partitioning Commands that are part of the ParCli product use the term “Core” while the EFI commands generally use the term “Root Cell”. The following section explains how to determine the Core Cell with the Operating System running. This procedure requires many more steps than the previous "Determining the Root/Core Cell" procedure described on page 12.

The sx1000-based HP Integrity servers are multi-partition servers, and as such can have multiple Cells in a partition. If a partition has more than one cell, then only one will be the “Core” cell with all others being termed a “Base” cell. For every partition on a system (often termed a “Complex”) there will be one Core Cell. Due to this it is assumed that the Partition Number or friendly name is already known for the OS instance that needs to be debugged.

To determine the Core Cell please use the following rules:

If the partition has only one Cell, it must be the Core Cell.

If the partition has more than one Cell, but only one I/O Chassis within the partition, then Cell with the I/O chassis will be the Core Cell.

If the partition has more than one Cell and more than one I/O Chassis then the following procedure can be used to determine the Core Cell. The following procedure can be used if the answers to the above statements are not known.

Prerequisites for Procedure

The IPMI Password is known for the HP Integrity sx1000 server. For more information on configuring the IPMI Password please review the “ParCLI nPartition Management” Manual available on the Smart Setup CD or at http://www.hp.com/.

A laptop or workstation is available and has Partition Manager Command Line Interface (ParCLI) installed on it. For more information on ParCLI please review the “ParCLI nPartition Management” Manual available on the Smart Setup CD or at http://www.hp.com/.

The IP Address or Hostname for the server’s Management Processor (MP) is known.

The laptop or workstation is placed on a network that can connect to the Management Processor over the LAN.

Use PARSTATUS to determine Core Cell.

If the above prerequisites are known then the PARSTATUS command can be issued from the command line with the following syntax.

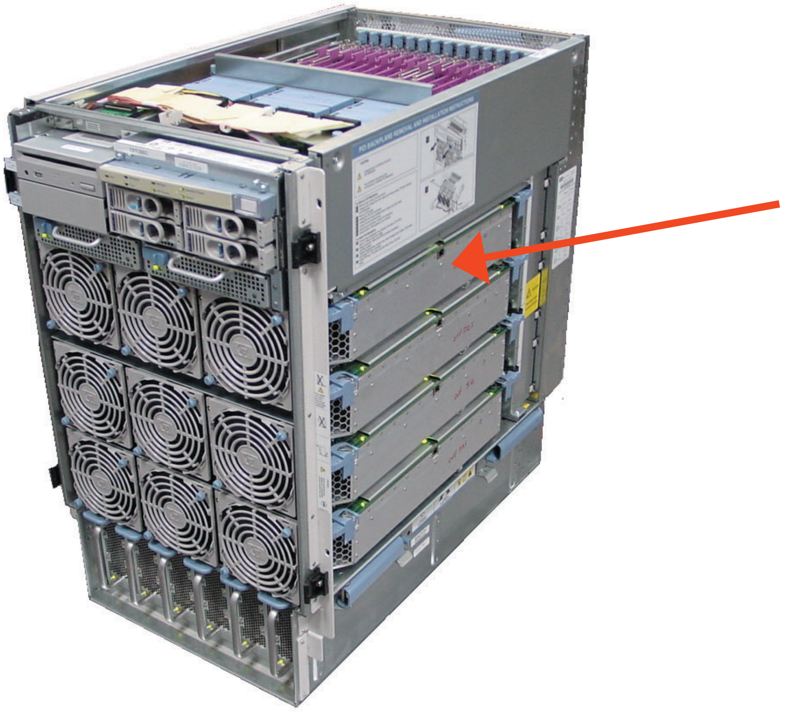
```
Parstatus -g ipmipassword -h ManagementProcessorAddress
```

The command may take up to 2 minutes to complete. Once it has completed the last block of text is needed to determine the Core Cell for the partition. The text lists the Partitions on the Complex, and also the hardware address of the Core Cell. The following text shows an example of the output.

```
[Partition]
Par              # of  # of I/O
Num Status       Cells Chassis  Core cell  Partition Name (first 30 chars)
=== ============ ===== ======== ========== ===============================
0   Active       2     2        cab0,cell0 RX8620-00 11.23
1   Active       2     2        cab0,cell1 RX8620-01 Windows 2003
```

The above output shows two partitions (determined by Par Num column) and for Par Num 0 the Core Cell is “Cab 0, Cell 0”, and for Par Num 1 the Core Cell is “Cab 0, Cell 1”.

In this rx8620 example, if the OS instance that needs to be debugged is Par Num 1, then the RJ45 connector must be connected to “Cell 1”.



Cell 1 Debug Port

Figure 8. Example of Debug Ports